WATER RESOURCES REPORT 9

WATER POSSIBILITIES FROM THE GLACIAL DRIFT OF DAVIESS COUNTY

BY

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MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES

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Harry Pick, and W. B. Russell

1957
(Reprinted without revision, 1970)

MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES ROLLA, MO.

William C. Hayes, State Geologist and Director

WATER POSSIBILITIES FROM THE GLACIAL DRIFT OF DAVIESS COUNTY

A special study of groundwater by the Missouri Geological Survey and Water Resources was made possible at the 1955 session of the Missouri Legislature. With the approval of the Governor, money was appropriated from the Missouri Post War Surplus Reserve Fund.

Since nearly two-thirds of the counties located north of the Missouri River are deficient in water supplies, much of the effort of this special study is being directed toward the problems of this area.

It has been shown that a program of test drilling can locate new reserves of groundwater. Potential areas are being tested so that additional supplies will be available for domestic, irrigation, industrial and municipal needs.

The most favorable areas are in the sand and gravel filled channels and valleys of pre-glacial and inter-glacial streams. Since these buried valleys do not conform to present day drainage patterns, a systematic program of test drilling is a principal means of locating the channels and mapping their extent. Such glacial deposits have proved to be excellent sources of groundwater.

QUALITY OF WATER FROM ROCK WELLS

The water from the consolidated rock formations which underlie Daviess County is, for the most part, mineralized. The following are analyses from water wells and oil tests:

CONSTITUENTS	IN PARTS PER MILLION				
	A	B	C	D	E
Turbidity	3	slight	slight	slight	sediment
Odor	none	musty	none	none	oily
pH	8.4				8.4
Alkalinity ($CaCO_3$)	551.5	354.0	818.6	343.9	496.5
Phenolpthalein	50.0				
Methyl Orange	501.5				
Carbonate (CO_3)	30.0	0.0	25.7	12.1	28.2
Bicarbonate (HCO_3)	611.8	431.7	998.3	419.4	548.4
Silica (SiO_2)	9.0	14.4	6.0	22.4	10.7
Oxides (Al_2O_3, Fe_2O_3, TiO_2, etc.)	1.3	0.30*	0.80*	0.30*	3.0
Calcium (Ca)	41.1	207.3	6.5	101.1	6.4

CONSTITUENTS	IN PARTS PER MILLION				
	A	B	C	D	E
Magnesium (Mg)	17.7	80.0	2.3	40.4	4.15
Sodium (Na) & Potassium (K) as Na	454.8	191.7	967.8	101.3	922.1
Total Manganese (Mn)	0.00		0.07	0.10	
Total Iron (Fe)	1.17	0.27	1.08	0.37	0.16
Dissolved Iron	0.07	0.07	0.28	0.07	
Precipitated Iron	1.10	0.20	0.08	0.30	
Sulfate (SO_4)	405.4	201.6	104.5	17.7	574.8
Chloride (Cl)	79.0	254.0	871.6	62.8	585.0
Nitrate (NO_3)	0.6	354.24	0.52	177.12	
Fluoride (F)	1.4		2.70	0.85	
Total Suspended Matter		7.4	0.8	4.2	
Total Dissolved Solids	1318.	1899.0	2432.0	891.0	2361.
Total Hardness	175.4	846.3	25.7	428.4	33.2
Carbonate Hardness	551.5	354.0		343.9	
Non-carbonate Hardness	0.0				
Percent of Alkalies	85	33	99	34	98

*Al_2O_3 only

A. Owner: Donald Waters, SW¼ NE¼ NE¼ sec. 22 T. 61 N., R. 28 W. Rock well? 280 feet deep. Sample from storage reservoir November 6, 1956. Analyst: M. E. Phillips.

B. Owner: "Shaw", now Ercell L. Rhodus, NW¼ SW¼ sec. 5, T. 58 N., R. 29 W. Total depth 410 feet. Yield 10 gallons per minute with a drawdown of 150 feet from a static water level of 50 feet. NOTE EXCESSIVE NITRATES. Analyzed October 9, 1935 by R. T. Rolufs.

C. Owner: W. J. Farnum, SW¼ SW¼ sec. 5, T. 58 N., R. 29 W. Total depth 365 feet. Analyzed September 6, 1935 by R. T. Rolufs.

D. Owner: Lindberg farm, SW¼ SE¼ sec. 32, T. 58 N., R. 29 W. Total depth 487 feet. NOTE EXCESSIVE NITRATES. Analyzed September 17, 1935 by R. T. Rolufs.

E. Owner: John Willman, Jr., Gould farm SW¼ SW¼ sec. 3, T. 58 N., R. 29 W. Total depth 945 feet. Water sampled September 1948 from the Cherokee of the Pennsylvanian System from the depth interval 490 to 520 feet. Analyst: M. E. Phillips.

CONSTITUENTS	IN PARTS PER MILLION				
	F	G	H	I	J
Turbidity	slight	slight	turbid	turbid	turbid
Odor	none	none	musty		
pH					
Alkalinity ($CaCO_3$)	308.1	770.7			523.4

CONSTITUENTS	IN PARTS PER MILLION				
	F	G	H	I	J
Phenolpthalein					
Methyl Orange					
Carbonate (CO_3)	0.0	31.8	4.0		0.0
Bicarbonate (HCO_3)	375.7	939.9	825.1		683.3
Silica (SiO_2)	24.0	7.6	9.6		5.2
Oxides (Al_2O_3, Fe_2O_3, TiO_2, etc.)	1.13*	0.33*	0.66*		3.20[1]
Calcium (Ca)	226.6	14.3	49.5		18.9
Magnesium (Mg)	72.3	8.8	17.7		9.6
Sodium (Na) & Potassium (K) as Na	164.8	804.5	961.9		989.8
Total Manganese (Mn)	0.10	0.04	0.24		
Total Iron (Fe)	3.15	2.15			
Dissolved Iron	0.05	0.05	0.10		
Precipitated Iron	3.10	2.10	4.60		
Sulfate (SO_4)	293.6	247.7	30.0	677.1	677.1
Chloride (Cl)	227.4	530.2	1144.2	713.0	713.0
Nitrate (NO_3)	253.04	7.38	2.21		
Fluoride (F)	0.60	4.80	2.40		3.30
Total Suspended Matter	12.8	22.2	645.2		
Total Dissolved Solids	1806.0	2211.0	2807.0	2748.0	2748.0
Total Hardness	862.9	71.8	196.3		86.6
Carbonate Hardness	308.1	71.8	196.3		86.6
Non-carbonate Hardness					
Percent of Alkalies	29	96	91		94

*Al_2O_3 only
1 Al_2O_3, Fe_2O_3

F. Owner: William Campbell - now Insurance Co. farm, NW¼ SE¼ sec. 36, T. 58 N., R. 29 W. Total depth 338 feet. 7½ gallons per minute with 140 feet of drawdown from a static water level of 60 feet. NOTE EXCESSIVE NITRATES. Analyzed October 11, 1935 by R. T. Rolufs.

G. Owner: J. C. Brownlee, SW¼ SW¼ sec. 34, T. 58 N., R. 28 W. Total depth 400 feet. Water sample from the Pennsylvanian System. Analyzed October 22, 1935 by R. T. Rolufs.

H. Owner: U. B. Adams, SE¼ SE¼ sec. 34, T. 58 N., R. 28 W. Total depth 360 feet. Analyzed September 20, 1935 by R. T. Rolufs.

I. Owner: Dr. H. H. Francis; Anna Lewis farm, NW¼ SW¼ sec. 28 T. 59N., R. 27 W. Total depth 762 feet? Bottomed in Mississippian System. Sample from interval 310 to 350 feet from "Squirrell" sand of the Cherokee Group of the Pennsylvanian System. Analyzed October 5, 1939 by R. T. Rolufs.

J. As I above. Sample from depth of 340 feet. Static water level 100 feet. Analyzed October 17, 1939 by R. T. Rolufs.

CONSTITUENTS	IN PARTS PER MILLION		
	K	L	M
Turbidity	turbid	slight	slight
Odor		none	musty
pH			
Alkalinity ($CaCO_3$)	273.2	306.9	626.6
Phenolpthalein			
Methyl Orange			
Carbonate (CO_3)	0.0	0.0	0.0
Bicarbonate (HCO_3)	333.2	374.3	764.2
Silica (SiO_2)	8.4	11.6	5.2
Oxides (Al_2O_3, Fe_2O_3, TiO_2, etc.)	5.20[1]	0.70*	0.0*
Calcium (Ca)	387.9	125.5	24.4
Magnesium (Mg)	146.4	10.3	9.3
Sodium (Na) and Potassium (K) as Na	2165.3	23.8	1624.7
Total Manganese (Mn)		0.05	0.06
Total Iron (Fe)		1.07	1.60
Dissolved Iron		0.07	0.60
Precipitated Iron		1.00	1.00
Sulfate (SO_4)	1486.5	45.3	0.4
Chloride (Cl)	3033.4	13.5	2256.9
Nitrate (NO_3)		27.67	0.0
Fluoride (F)	1.8	0.10	2.20
Total Suspended Matter		7.8	30.2
Total Dissolved Solids	7872.0	519.0	4512.0
Total Hardness	1570.0	356.0	99.1
Carbonate Hardness	273.2	306.9	99.1
Non-carbonate Hardness			
Percent of Alkalies	75	13	97

*Al_2O_3 only
1 Al_2O_3, Fe_2O_3

K. As I above. Sample from a depth of 690 feet, Cherokee Group, Pennsylvanian System. Analyzed November 16, 1939 by R. T. Rolufs.

L. Owner: E. H. Henry, SW¼ NE¼ sec. 9, T. 58 N., R. 27 W. Total depth 410 feet. Yield 10 gallons per minute with 80 feet of drawdown from a static water level of 20 feet. Analyzed September 7, 1935 by R. T. Rolufs.

M. Owner: Fred Cox, SE¼ NE¼ sec. 33, T. 58 N., R. 27 W. Total depth 364 feet. Analyzed August 6, 1935 by R. T. Rolufs.

Referring to Plate 1, it will be noted that a large area of Daviess County is unfavorably located to obtain water from glacial drift. Wells drilled into the consolidated rock to moderate depths may possibly obtain limited yields of water of marginal quality. The water from "rock" wells in all probabilities will become more mineralized with increased depth of

drilling.

QUALITY AND QUANTITY OF WATER FROM STREAMS

The streams of Daviess County, with the exception of the Grand River, are intermittent in their flow. Though the quality of water is usually satisfactory, the undependable flow makes all streams other than the Grand River unsuitable for irrigation or for municipal use. The Grand River is being used as a water source for municipal needs and to some extent for irrigation.

The following are the results of an analyses of a water sample collected November 22, 1955 from the Grand River near Gallatin, sec. 16, T. 59 N. R. 27 W. River stage 1.86 feet. Temperature of water 41° F., of the air 52° F. Analyst: M. E. Phillips.

CONSTITUENTS	IN PARTS PER MILLION
Turbidity	20
Odor	none
pH	7.8
Alkalinity ($CaCO_3$)	217.0
Phenolpthalein	10.0
Methyl Orange	207.0
Carbonate (CO_3)	6.0
Bicarbonate (HCO_3)	252.5
Silica (SiO_2)	5.6
Oxides (Al_2O_3, Fe_2O_3, TiO_2m etc.)	0.8
Calcium (Ca)	70.5
Magnesium (Mg)	13.7
Sodium (Na) and Potassium (K) as Na	16.1
Total Manganese (Mn)	0.00
Total Iron (Fe)	0.78
Dissolved Iron	0.11
Precipitated Iron	0.67
Sulfate (SO_4)	35.4
Chloride (Cl)	6.3
Nitrate (NO_3)	0.0
Fluoride (F)	0.2
Total Suspended Matter	11.
Total Dissolved Solids	292.
Total Hardness	232.5
Carbonate Hardness	217.0
Non-carbonate Hardness	15.5
Percent of Alkalies	13

The following are stream flow data from: Bolon, Harry C., Surface Waters of Missouri; Missouri Geological Survey and Water Resources, 2d ser.,

vol. 34, p. 307, 1952.

Grand River near Gallatin

Location. - Water-stage recorder, lat. 39° 55' 35", long. 93° 56' 35", in SW¼ NW¼ sec. 16, T. 59 N., R. 27 W., at bridge on State Highway 6, 100 feet downstream from Chicago, Rock Island & Pacific Railway Bridge, 1 mile northeast of Gallatin, and 6 miles upstream from Honey Creek.
Datum of gage is 712.56 feet above mean sea level, datum of 1929.

Drainage Area. - 2,250 square miles

Records Available. - June 1921 to September 1949.

Average Discharge. - 28 years, 1,103 second-feet.

Extremes. - 1921-49: Maximum discharge, 69,100 second-feet June 24, 1947; maximum gage-height, 37.02 feet June 2, 1929 (present site and datum); minimum discharge, 2.4 second-feet October 24, 25, 1939. Maximum stage known, about 40 feet, July 8, 1909, from floodmarks.

Revisions. - The maximum discharge and gage-heights for the water year 1926 have been revised to 53,200 second-feet September 17, 1926 (gage height, 36.80 feet) superseding figures published in "Water Resources of Missouri, 1857-1926" Vol. XX, Second Series.

Remarks. - Records fair to good except those periods of ice effect and no gage-height record, which are poor.

Cooperation. - Station maintained by U.S.G.S. Surface Water Branch in cooperation with Corps of Engineers. Gage-height record collected in cooperation with U. S. Weather Bureau.

QUALITY OF WATER FROM GLACIAL DRIFT

In general, the water from the glacial drift is high in total iron, total dissolved solids, and sulfates. The iron content in the water may cause staining of plumbing fixtures and laundry; however, relatively inexpensive water treatment for the iron will prevent this staining. For most types of irrigation, total dissolved solids should not exceed 2000 parts per million and total alkalies should not exceed 75 percent. Most people cannot tolerate water for drinking purposes which contains more than 1500 parts per million of chloride, or 2000 parts per million sulfate. Water with 300 parts per million of chloride tastes salty to some people. Sulfates in excess of 500 parts per million may have a laxative effect when first used for drinking.

Several of the water samples from the "rock" wells and one of the samples from drift materials contained excessive nitrates. The following is quoted from the article, The Public Health Significance of High Nitrate Waters As a Cause of Infant Cyonosis and Methods of Control, Metzler, D. F., and Stoltenberg, H. A., Trans. Kansas Acad. Scie. Vol. 53, No. 2, p. 194 and 205, 1959.

"The cyonosis of infants can be caused by the ingestion of nitrates in the water used for making the feeding formula. The nitrates are converted to nitrites and absorbed by the blood, where they destroy its oxygen-carrying properties. The blood becomes chocolate brown, the skin develops a blue color and death may result from oxygen starvation".

"Nitrate concentrations exceeding 10 to 20 ppm of nitrate nitrogen are considered unsafe."

The following are eight analyses from glacial drift wells.

CONSTITUENTS	IN PARTS PER MILLION			
	1	2	3	4
Turbidity	25	20.0	1	1
Odor	none		none	none
pH	7.8	6.0	7.8	7.8
Alkalinity ($CaCO_3$)	401.5	46.0	34.5	260.5
Phenolpthalein	0.0	0	0.0	0.0
Methyl Orange	401.5	46.0	34.5	260.5
Carbonate (CO_3)	0.0	0	0.0	0.0
Bicarbonate (HCO_3)	489.8	56.0	42.1	317.8
Silica (SiO_2)	14.5	10.0	17.6	19.0
Oxides (Al_2O_3, Fe_2O_3, TiO_2, etc.)	2.0		1.0	1.0
Calcium (Ca)	83.8	65.6	64.1	121.1
Magnesium (Mg)	30.5	14.5	13.3	29.9
Sodium (Na) & Potassium (K) as Na	123.9	24.2	31.5	56.6
Total Manganese (Mn)	0.19		0.22	0.00
Total Iron (Fe)	5.32	1.0	0.28	0.20
Dissolved Iron	0.31		0.04	0.05
Precipitated Iron	5.01		0.24	0.15
Sulfate (SO_4)	146.8	153.3	157.3	17.5
Chloride (Cl)	8.5	31.6	28.5	46.0
Nitrate (NO_3)	8.4	19.5	18.3	228.8
Fluoride (F)	0.4	0.1	0.3	0.5
Total Suspended Matter	19.		27.	36.
Total Dissolved Solids	649.	405.0	361.	715.
Total Hardness	334.8	224.0	214.9	425.5
Carbonate Hardness	401.5	46.0	34.5	260.5
Non-carbonate Hardness	0.	178.0	180.3	165.0
Percent of Alkalies	45	19	24	22

1. Owner: Coffey Lions Club, SW¼ SW¼ SW¼ sec. 1, T. 61 N., R. 28 W. Total depth between 150 and 175 feet. Sample direct from pump November 6, 1956. Temperature of water 57° F., of the air 62° F. Analyst: M. E. Phillips.

2. Owner: Pattonsburg School District R. 2, Hole number 1. Total depth 60 feet 6 inches. Screen set 35 to 40 feet. Yield 30 gallons per minute with 6 feet 8 inches of drawdown from a static water level of 22 feet. Analyzed by the Missouri Division of Health.

3. Owner: Pattonsburg School, well number 2 SW¼ NW¼ NW¼ sec. 35, T. 61 N. R. 29 W. Total depth 40 feet. Sampled from pressure system November 6, 1956. Analyst: M. E. Phillips.

4. Owner: Forest Pogue, NE¼ NE¼ SE¼ sec. 23, T. 60 N., R. 27 W. Total depth 120 feet. Static water level 30 feet. Sampled direct from pump October 31, 1956. Temperature of water 55° F., of the air 60° F. Analyst: M. E. Phillips.

CONSTITUENTS	IN PARTS PER MILLION			
	5	6	7	8
Turbidity	15	slight	clear	50
Odor	none	none	none	none
pH	8.4			7.3
Alkalinity ($CaCO_3$)	369.5	278.5	284.6	226.5
Phenolpthalein	0.0			0.0
Methyl Orange	369.5			226.5
Carbonate (CO_3)	0.0	0.0	0.0	0.0
Bicarbonate (HCO_3)	450.8	339.6	347.1	276.3
Silica (SiO_2)	9.5	6.4	11.6	17.3
Oxides (Al_2O_3, Fe_2O_3, TiO_2 etc.)	1.3	0.19*	1.50*	1.8
Calcium (Ca)	109.1	137.1	140.6	143.9
Magnesium (Mg)	39.9	11.6	12.4	16.1
Sodium (Na) & Potassium (K) as Na	129.4	14.5	14.2	37.8
Total Manganese (Mn)	0.22	0.20	0.10	1.02
Total Iron (Fe)	2.92	1.85		11.36
Dissolved Iron	0.09	0.15	0.07	0.21
Precipitated Iron	2.83	1.70	none	11.15
Sulfate (SO_4)	291.4	120.6	134.6	167.3
Chloride (Cl)	10.0	10.9	9.5	48.5
Nitrate (NO_3)	7.8	6.51	2.26	2.2
Fluoride (F)	0.4	0.25	0.20	0.3
Total Suspended Matter	33.	9.4		40.
Total Dissolved Solids	827.	558.0	555.0	598.
Total Hardness	436.7	390.3	402.3	425.7
Carbonate Hardness	369.5	278.5	284.6	226.5
Non-carbonate Hardness	67.2			199.2
Percent of Alkalies	39	7	7	16

*Al_2O_3 only

5. Owner: Harry Kissinger, SE¼ SE¼ SE¼ sec. 34, T. 59 N., R. 28 W. Total depth 120 feet. Static water level 50 feet. Sampled direct from pump November 8, 1956. Temperature of water 54° F., of the air 47° F. Analyst: M. E. Phillips.

6. Owner: City of Gallatin. Total depth 47 feet. Analyzed July 23, 1936 by R. T. Rolufs.

7. As above. Static water level 13 feet. Dug in 1888. Analyzed February

16, 1937 by R. T. Rolufs.

8. Owner: Victor Litton, NE¼ SE¼ SE¼ sec. 11, T. 58N, R. 26 W. Total depth 65 feet. Static water level 20 feet (?). Sampled October 31, 1956 from the pressure system. Analyst: M. E. Phillips.

QUANTITY OF WATER FROM GLACIAL DRIFT

DOMESTIC WELLS - Included in this category are wells developed for household or general farm use. Yields required from domestic wells vary but seldom exceed 15 gallons per minute. In some parts of Daviess County sands and gravels were not deposited in the glacial drift. There are also areas where the glacial drift cover is relatively thin or lacking. In such areas the possibility of developing wells is limited. Plate 1 shows the area most favorable for the development of domestic wells. Plate 3 is a contour map showing the elevation of bedrock above sea level. To determine probable drilling depths, the elevation of the bedrock should be subtracted from the surface elevation for each specific site. Plate 3 shows the locations of the test holes and the thickness of the glacial drift encountered.

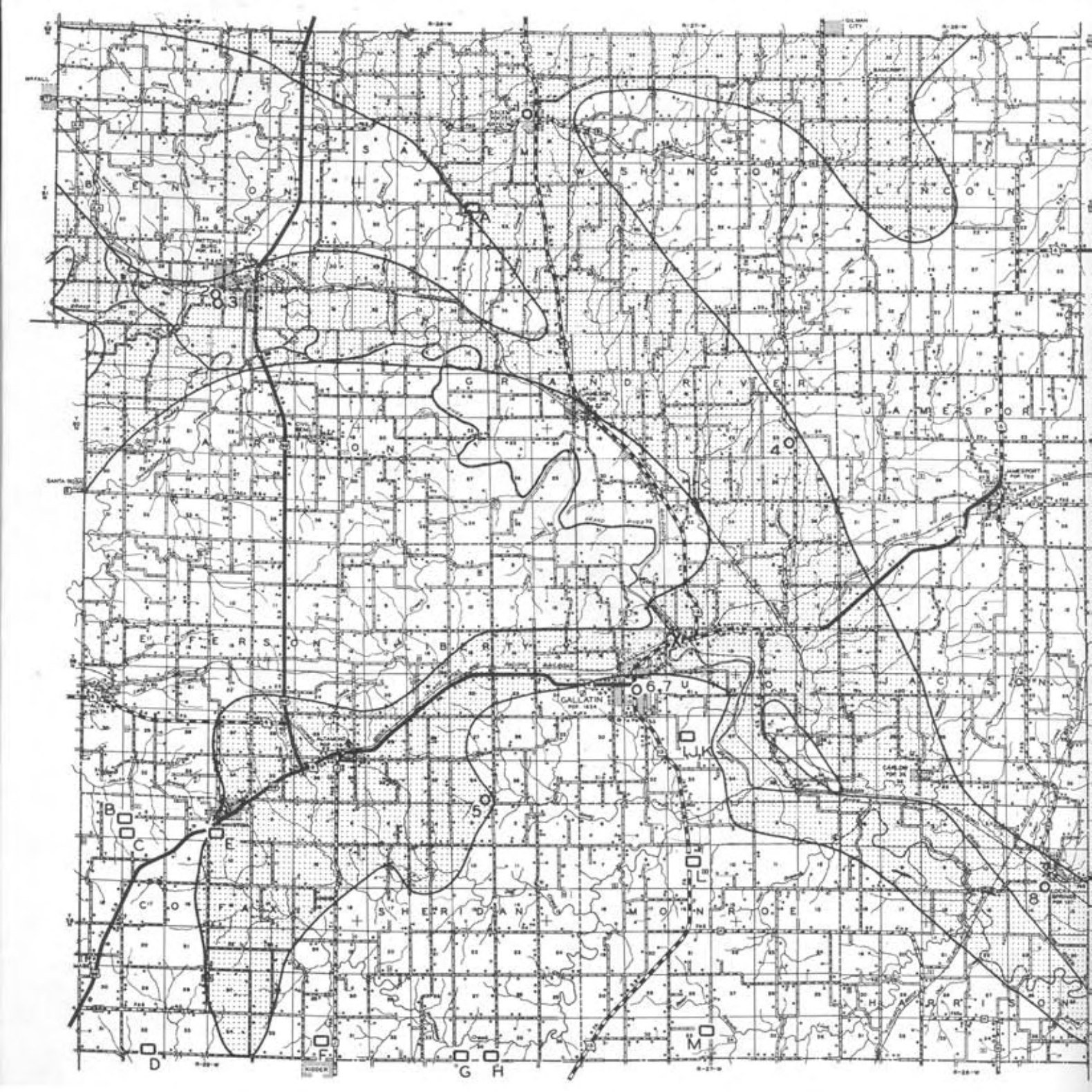
IRRIGATION WELLS - Included in this category are all high yield wells whether used by cities, by industries, or for irrigation. Plate 2 shows the area most favorable for the development of irrigation wells. Also shown are the locations of seven wells which flowed. Although not shown as favorable on Plate 2, the Grand River Valley may possibly be capable of supporting irrigation wells in portions of its length.

With proper development, yields of 200-1000 gallons per minute may be obtained. An irrigation well 80 feet deep located in the Grand River Valley in Livingston County has a yield of 800 gallons per minute. Yields to be expected are contingent upon several factors:

(1) The thickness of the sand and gravel beds.
(2) The size and sorting of the sand and gravel.
(3) The manner of construction and materials used, such as proper well screen, gravel pack, etc.
(4) Ability of the well driller to develop the full capacity of the water bearing sands.

Continued successful production is contingent upon:

(1) Re-charge rate of the water-bearing horizons.
(2) Quality of the screen and materials used.
(3) Subsequent well treatment such as acidizing.
(4) Avoidance of over-pumpage.



Base by the Missouri State Highway Department, 1951

LEGEND

- *Area most favorable*
- O_4 *Location of wells in drift from which water was analyzed*
- $\square H$ *Water sample analyzed from a "rock" well*
- X *Water sample analyzed from a stream*

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PLATE 1

MAP OF DAVIESS COUNTY
SHOWING
AREA MOST FAVORABLE FOR THE DEVELOPMENT OF WELLS IN DRIFT

BY
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1957

MISSOURI GEOLOGICAL SURVEY
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ROLLA, MISSOURI

THOMAS R. BEVERIDGE
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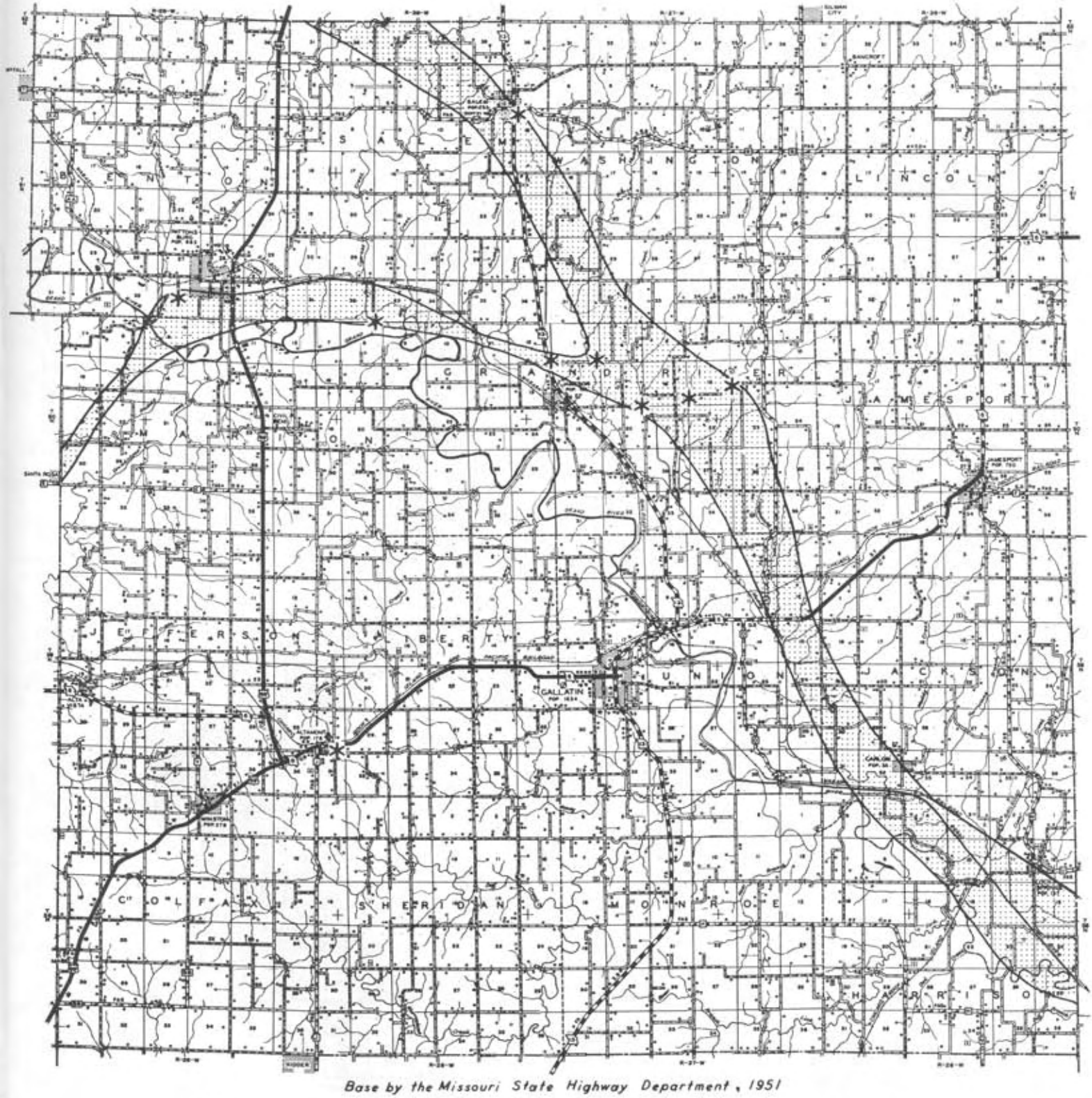

Base by the Missouri State Highway Department, 1951

LEGEND

Drift filled valley

* *Test wells that flowed*

-N-

MAP OF DAVIESS COUNTY
SHOWING
DRIFT FILLED VALLEYS IN WHICH IRRIGATION WELLS POSSIBLY CAN BE DEVELOPED

BY
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1957

MISSOURI GEOLOGICAL SURVEY
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ROLLA, MISSOURI

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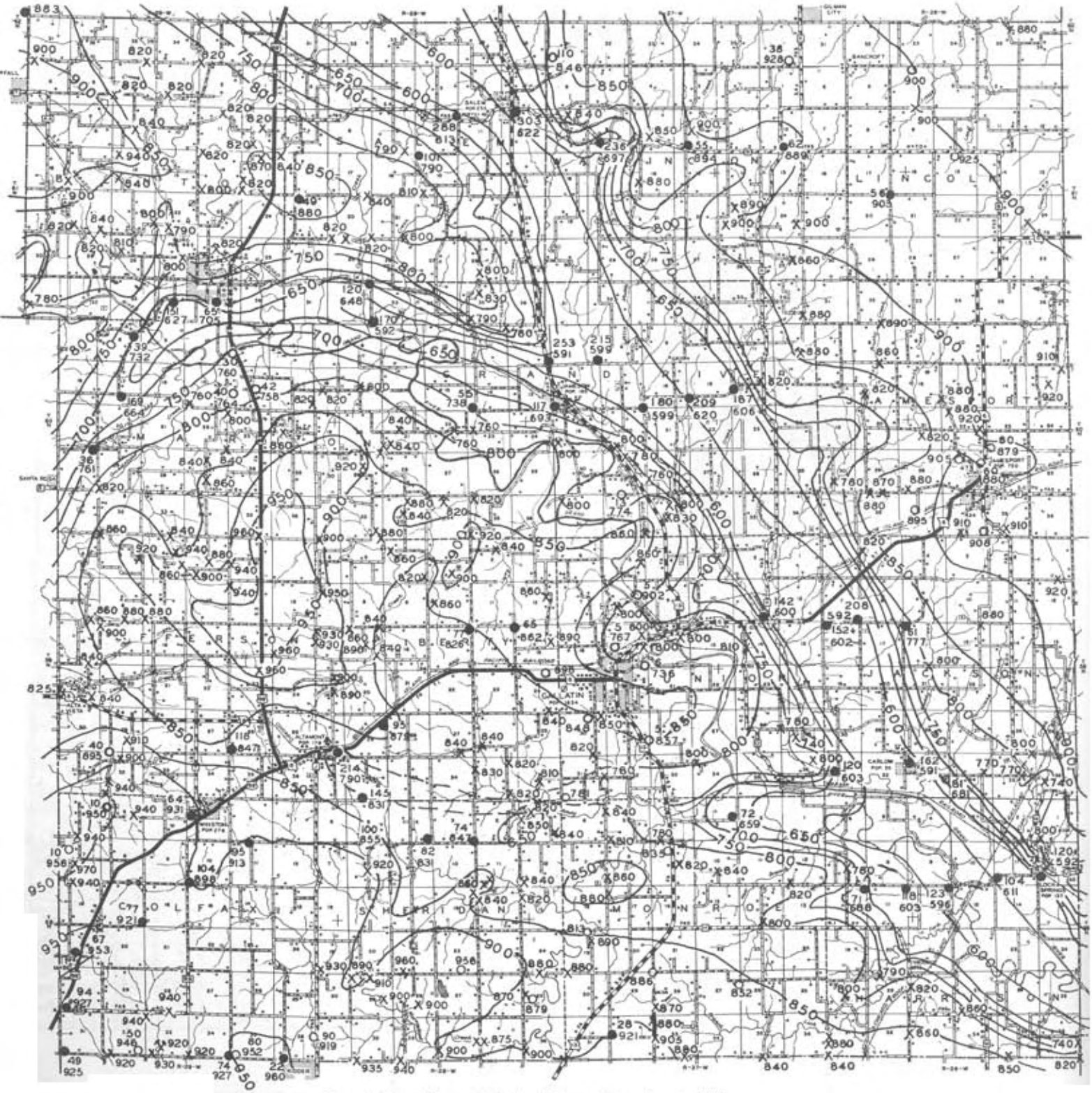
PLATE 2



Base by the Missouri State Highway Department, 1951

LEGEND

- 135 / 650 — *Test holes showing thickness in feet of drift and elevation of bedrock above sea level*
- O — *Water wells*
- X — *Bedrock Outcrops*
- ⚒ — *Mine or Quarry*
- 920 — *Indicates outcrop elevation*

N

CONTOUR MAP
OF
DAVIESS COUNTY
SHOWING
BEDROCK ELEVATIONS
BY
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J. R. McMILLEN
HARRY PICK
W. B. RUSSELL
1957
MISSOURI GEOLOGICAL SURVEY
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ROLLA, MISSOURI

THOMAS R. BEVERIDGE
STATE GEOLOGIST

PLATE 3

SUMMARY

Approximately 25,000 acres of Daviess County are located within the area in which irrigation wells possibly can be developed. Nearly one-third of Daviess County's area is suitably located for obtaining water sufficient for domestic needs from the glacial drift.

Questions concerning water problems for a specific location should be sent to the Missouri Geological Survey, Box 250 Buehler Park, Rolla, Missouri 65401